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RESPONSE OF SEATED AND STANDING MANIKIN DURING SHOCK TRIALS ON U.S.S. MOBILE BAY (CG53) AND U.S.S. ROOSEVELT (CVN71)

A. E. Hirsch, S. J. Shaibani, and T. T. Nguyen

Chi Associates, Inc., Suite 310,
2000 N. 14th Street, Arlington, VA 22201

and

G. C. Willems, W. H. Muzzy III, and D. R. Knouse

Naval Biodynamics Laboratory
Box 29407
New Orleans, LA 70189-0407

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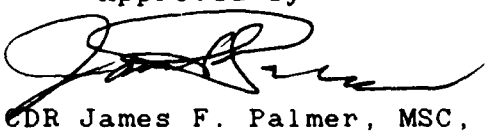

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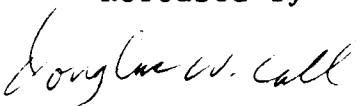

CAPT Douglas W. Call, MSC, USN
Commanding Officer

Naval Biodynamics Laboratory
P.O. Box 29407
New Orleans, LA 70189-0407

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The response of seated and standing manikins to shock motions generated during shock trials on U.S.S. MOBILE BAY (CG53) and U.S.S. ROOSEVELT (CVN71) were studied. It was found that the deck motion in the CIC compartment of CG53 was largely in the z or upwardly directed vector. However in addition to this gross heaving there was superimposed a large relatively undamped 10 Hertz oscillation. Such motion could have significant influence on injury production and seriously compromise current protective design for seated personnel. Deck motions observed on the CVN71 contained, in addition to large z direction components, almost equally, large x (surge) and y (sway) components which could contribute significantly to injury production for unprotected personnel and seriously compromise the effectiveness of current equipment design for personnel protection against ship shock motions.

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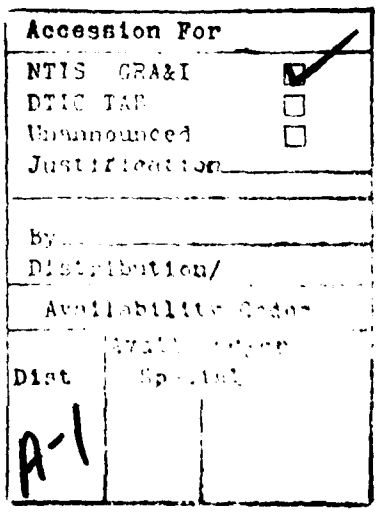

RESPONSE OF SEATED AND STANDING MANIKIN DURING SHOCK TRIALS ON U.S.S. MOBILE BAY (CG53) AND U.S.S. ROOSEVELT (CVN71)

1. INTRODUCTION

There has been a growing awareness in the Armed Services and Congress that our highly sophisticated and expensive military equipment will function effectively to the extent that the personnel responsible for its operation can function effectively.

James F. O'Bryon, Assistant Deputy Director, Defense R and E, has pointed out:

"Our fighting men and women are the most vital asset we possess in the defense of our nation. Weapons are necessary, but it is these people who make them function. The Live Fire Test legislation recently passed by Congress recognizes the importance of protecting our fighting forces and also gives priority to the timely, honest and thorough assessment of their vulnerabilities." [1]*

One response to this awareness as well as the congressional mandate was sponsorship by Mr. O'Bryon's office of a LIVE FIRE TEST CREW CASUALTY ASSESSMENT WORKSHOP, held at the Naval Submarine Base, Groton, Connecticut in October 1988. Background justification for the meeting includes the following:

"Mission effectiveness is dependent upon equipment failures and/or crew/personnel failures. While considerable attention has been paid to equipment failures and the effects of weapons on equipment, little attention has been paid to the role of crew members, and how weapons effects influence their performance, and the resulting impact on system performance. Weapons system effectiveness depends upon the crew's ability to sense, think, move, and communicate." [2]

The above statement is applicable to operational units of our armed forces. Among these, Naval units are of particular importance because of the large concentration of combat personnel encapsulated in a single extremely complex and costly combat entity. Among other hazards, naval personnel are subject to the incapacitating effects of ship shock motion resulting from underwater explosion attack. Studies by the Navy in the 1950's and 1960's addressed this problem and suggested protective counter measures. [3-9] The material covered and data utilized involved small fleet units and World War II weapons. Modern weaponry and ship construction have changed since that period. A reevaluation, and more serious efforts to quantify the shock effects on ship operational personnel, are certainly called for if the concerns of Congress and the Secretary of Defense are to be addressed.

* Numbers in brackets designate references at the end of paper.

Over the past few years the Naval Sea Systems Command (NAVSEASYSCOM) has conducted Ship Shock Trials as an ongoing effort, to examine the performance of selected manned and operational fleet units subjected to a series of graduated underwater explosion attacks. The purpose of such tests, in part, is to identify those elements of structure, equipment, and weaponry where damage or impairment would be indicated. The ships were manned but, in order to protect the crew from injury, personnel were instructed to assume a crouched position while bracing themselves during the tests. Information regarding human response then, is of necessity derived from human surrogates. The Naval Biodynamics Laboratory (NAVBIODYNLAB) was charged with the task of providing appropriate human surrogates (manikins) and measuring the deck and manikin responses at selected shipboard sites. This was performed during the shock trials held in the summer of 1987 on two ships the U.S.S. MOBILE BAY (CG53) and the U.S.S. ROOSEVELT (CVN71).

This report presents the measures made of the deck response and associated manikin motions as measured by NAVBIODYNLAB, and it discusses the implications relative to the production of combat ineffectives (CIs) on those ships.

2. TEST PROCEDURE

The NAVBIODYNLAB has unique capabilities in the Navy for high speed dynamic measurements on human subjects and human surrogates (manikins). For this reason, it was selected to obtain the measurements on human surrogate responses aboard the two ships, CG53 and CVN71.

Locations were chosen on the ships which met one of the following criteria:

(a) As close as possible to the section that would receive maximum shock loads

(b) Important to critical ship operations

Adhering to the above criteria, the Combat Information Center (CIC) aboard the CG53 and the Universal Weapons Magazine compartment G-138-0-M on the CVN71 were chosen.

NAVBIODYNLAB selected the fiftieth percentile Hybrid III [10, 11] manikin (Figure 1) for this project. It is the most advanced available test device in terms of biofidelity and represents the average male population's weight and physique. The Hybrid III is the Federal Government's standard test device for evaluating automotive restraint systems.

Only one instrument package and manikin was available per test; hence, the responses of seated and stiff-legged standing manikins could only be studied in separate tests.

FIGURE 1. Seat and manikin use for tests 1-4 on the CG53 trials.

2.1 Seated Position, CG53. A manikin was seated on a special purpose operator's chair (Figure 1) in the CIC at Fire Control Console No. 2. This console is on the port side of the ship and the seat faces aft. The chair was adjusted in the mid position vertically and in the fore and aft direction with the arm rests stowed vertically against the seat back (Figure 2). Prior to each shot the manikin was seated in the chair with arms folded in the lap and with legs secured to the attached foot rung with cord. One exception to this condition was the fourth shot, for which the ship's Captain placed the manikin's arms on the console instead of in the lap. Any change in the location of the manikin's center of gravity and moments of inertia, and in the type of shock loading, may have influenced its response to the input pulse for Test 4.

2.2 Standing Position, CVN71. A manikin was placed facing forward in a standing configuration in compartment 6-138-0-M of the CVN71 (Figure 3). The empty magazine provided ample space to install NAVBIODYNLAB's shock-mounted data acquisition system adjacent to the manikin. This configuration provided an ideal environment for the conditioning and transmission of low level transducer signal outputs.

3. INSTRUMENTATION

3.1 Seated Position, CG53. The shock input and resultant dynamic response of the manikin were measured using five accelerometer clusters. Four local coordinate systems were defined, one each at the chair pedestal, the manikin's pelvic area, upper thorax area and the head. The x-vector for the absolute coordinate system was defined as positive in forward direction parallel to the ship center line, the y-vector was directed laterally with left as positive, and the z-vector vertically positive against gravity. Triaxial linear accelerometers were placed at each of these locations measure accelerations along the local x, y and z axes at each of the four locations. One exception was the pelvis, at which a biaxial x and z axis accelerometer was used. Additionally, the head instrumentation package included a triaxial angular accelerometer, deployed to measure angular accelerations about the three axes. This additional head instrumentation was deemed necessary, because substantial head rotation has been observed in prior research involving inputs similar to those expected in the ship shock trials, and because such rotation is thought to be a significant head injury parameter. [12]

The accelerometer outputs were amplified and conditioned prior to being routed to the digital data acquisition system. All data paths, from transducer through the analog-to-digital converters, were calibrated immediately prior to each shot by replacing the transducers' outputs with a voltage source that produced known multi-step voltages. This technique eliminates concern with long-term changes in system sensitivity.

Data collection was implemented via on-line digitization procedures, using an industrial-grade microcomputer-based data collection subsystem. This technique had several advantages:

FIGURE 2. Manikin seated in test position at console no 2. facing aft on port side of CIC of CG53.

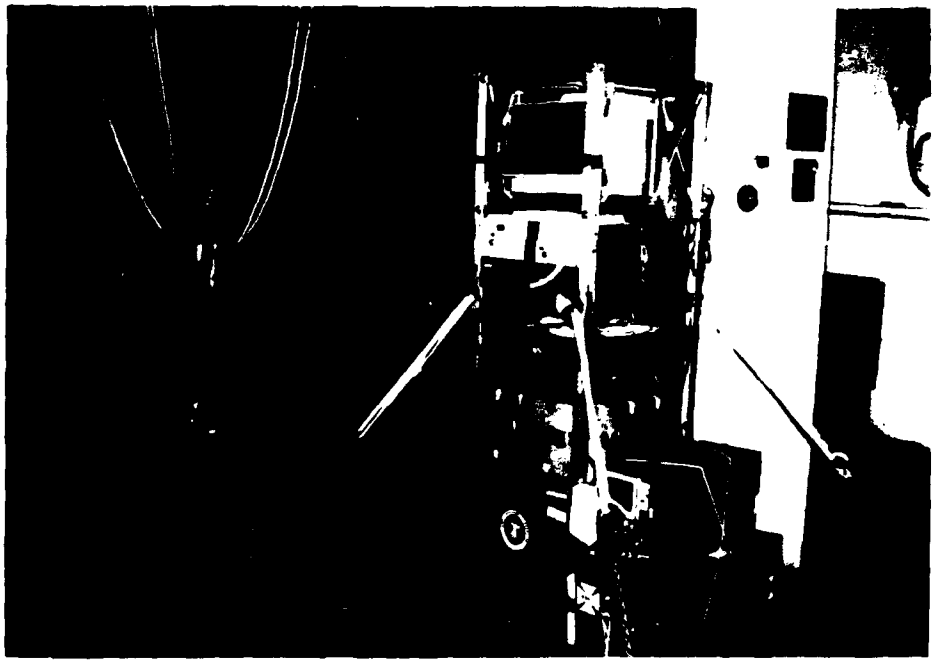

FIGURE 3. Standing foreward facing manikin in compartment 6-138-0-M of the CVN71.

(a) The need for post-shot off-line digitization was eliminated.

(b) Data could be readily scaled to physical units and plotted, providing "quick look" data in a timely manner.

(c) Preliminary analysis in the field was possible.

3.2 Standing Position, CVN71. Instrumentation for this test series was essentially identical with that for the seated with the exception that the triaxial accelerometer at the base of the chair was, in this case, placed on the deck adjacent to the standing manikin. The term chair/deck will be used to refer to the response of that part of the ship which is immediately adjacent to the manikin.

4. ANALYTICAL PROCEDURES

Data captured in each shock trial were entered into 15 separate files, which were encoded according to the American Standard Code for Information Interchange (ASCII) format for later processing by computer. One file was set aside for each of the 14 direction vectors found at the five accelerometer locations described earlier and one for the timing signal trace. Each file contained 743 records in which there was just one field. The first 13 records were given as string quantities and these were used for documentation and identification purposes. The other 730 records were numerical quantities, which represented the digitized forms of the analog output from the accelerometers. The sampling rate for the latter was 1500 per second, indicating a total recorded duration of 729/1500 = 0.486 seconds. Each file was loaded into a Lotus spreadsheet written on a microcomputer specially for this study. The conversion of the digitized data in each file to real units (either "g" or radian/sec/sec) was achieved within the spreadsheet by:

(a) undoing the analog-to-digital process, which meant dividing by 204.7 and subtracting 10; then,

(b) removing any initial bias, which was effected by subtracting the average value found in the lead-in part of the signal before the shock event took place; followed by,

(c) dividing by the physical calibration of the accelerometer sensitivity, the value of which appeared as the twelfth record of the data file; and, finally,

(d) dividing by the instrumentation amplifier gain, the value of which was held in the eleventh record of the data file.

The acceleration histories derived from the above manipulation were filtered within the Lotus spreadsheet by invoking a second-order Butterworth algorithm, which involves both a forward and a backward pass of the data. It is believed that this is the first instance in which such filtering has been implemented in the microcomputer environment. Filter frequencies of 15, 30, 60, 100 and 300 Hz were chosen in accordance with

the standard values adopted by the United States Department of Transportation (DOT) in their minicomputer analysis of raw data of human surrogate responses in automotive crash tests. Filter values of 500 and 1000 Hz are also employed by DOT in some applications, but these were not used in this study because they were too high to be meaningful for the sampling rate of 1500 per second.

The raw data, and the filtered results, for each acceleration history were further analyzed within the Lotus spreadsheet by integrating once to obtain the velocity history and by integrating a second time to produce the displacement history. These integrations did not include correction factors for any time-dependent bias because no well-defined end-points were reached within the 486 milliseconds interval (less approximately 200 milliseconds of pre-test lead-in) available for data recording. In other words, it was never possible to detect reliably the genuine end of the shock event when the manikin or the chair/deck could be considered to be at rest.

Clearly, this problem of not having the terminal velocity at zero can introduce numerical difficulties in the results. Empirical subjectivity in visual inspection of the data might be undertaken; however, recourse to this inexact technique is not recommended when the end-points cannot be established unambiguously. The uncertainty in the absolute results, obtained without suitable correction factors, can be mitigated by the realization that comparisons between different direction vectors will probably be quite valid. This is because any distortions in the results should be systematic, allowing bias errors to be ignored since they can be expected to be proportional, or in some other way consistent, throughout the analysis.

For each triaxial accelerometer, resultant values were calculated within a second Lotus spreadsheet. Values from all accelerometers on the manikin were calculated relative to chair/deck within a third Lotus spreadsheet. It should be noted that these relative values are not strictly a true physical indicator unless the initial orientations of the accelerometers remain fairly constant or nearly parallel, thus allowing each local frame of reference to be preserved in a relative sense. Any departures from this may cause unusual results but this should not be too serious because only the general overall response of the manikin needs to be determined.

The trigger signal for the third CG53 shock trial was late and the absence of a pre-shot lead-in meant that the results calculated for this trial cannot be analyzed with any confidence. The standard pre-test lead-in of about 200 milliseconds observed in the other shock trials was reduced to about 100 milliseconds in the fourth CG53 test.

5. TEST RESULTS

5.1 U.S.S. MOBILE BAY (CG53). The series consisted of four tests with increasing shock severity. Maximum values of deck and manikin response from each of the four tests are included in tabular form as Appendix A, at the end of this report.

Shock motions during Test 3 and 4 in the CIC compartment at the seat base are tabulated as part of Table 1. As would be expected, the velocities and displacements measured on the deck at this position are largely in the upward or z direction. It can be seen from this table that the maximum measures of deck motion derived from Test 3 data are so large as to indicate some measurement error, which was ascribed to the absence of a pre-shot lead-in in the files for this test. For the purposes of this study, the measures have been reported, but not utilized in the discussion.

The manikin representing the operator at console is shown seated and belted in a working position in Figure 2. His feet, which cannot be seen in the figure, are tied to the foot rest. The maximum measured responses during Shot 4 are tabulated on pages 16A-20A of Appendix A. Table 2 is a summary of these values. The resultant head rotational accelerations were between about 1300 to 1800 radian/sec/sec for the unfiltered and 60 Hz filtered measures, respectively. Absolute z direction accelerations recorded for position T-1 show little difference between filtered and unfiltered measures, which range from 10.3 to 10.4 g.

Motions recorded at the pelvis, which is restrained by the seatbelt and separated from the chair seat by a resilient cushion, show absolute maximum acceleration in the z direction of about 12 g in the filtered and unfiltered modes. The absolute velocity reached is computed to be 88.8 in/sec. Deck velocity in the z direction peaked at 73.97 in/sec. Absolute displacements in z as a function of time are plotted in Figure 4. The initial zero has been arbitrarily adjusted to the time at which a series of significant signals are initiated at the deck accelerometer.

The curves show that the deck resonates at 10 Hz with a fairly high amplitude, which is relatively undamped. It also indicates that the dummy reacts to the initial shock by compressing the seat about an inch or so, and then taking off at about 50 msec. He bottoms on the lap belt at about 100 msec and then contacts the cushion on the downward rebound at about 250 msec just in time to receive a jolt from the chair, which is moving upward at this time. The above displacement details may be more clearly seen on Figure 5, which has been derived to show the displacement with time, of the pelvis and T-1 relative to the rigid seat bottom (deck).

5.2 U.S.S. ROOSEVELT (CVN71). This series consisted of four tests of increasing severity with the manikin utilized in the Mobile Bay series, now in an erect st[illegible]ing position. Due to premature triggering pulse equipment, data wer[illegible] not recorded for Test 1 in the series. The maximum measured response[illegible]ring Shot 4 are tabulated on pages 11B-15B of Appendix B. Summary of significant motions are included on Table 3. Deck motions show a diffe[illegible] pattern from those measured on the CG53. Figure 6 is a comparison of [illegible]e z direction deck displacements for Test 4 on the CVN71 and CG53.

As can be seen, there was no large amplitude 10 Hz z vibration experienced by the deck in the weapons compartment. The maximum displacement upward (z), is 8.78 inches for the CVN71 and 2.46 inches for the CG53. Also, it appears that there was considerably different surging or forward motion (x) shown on Table 1, where 0.9 inches was observed on

TABLE 1 - Maximum Absolute Velocities and Displacements of Deck (60 HZ filter)

TEST	VECTOR	VELOCITY in./sec.	DISPLACEMENT in.
CG53 TEST 4	X	11.64	-0.85
	Y	15.41	0.57
	Z	73.97	2.46
CG53 TEST 3	X	-51.36	-11.58
	Y	49.75	10.98
	Z	173.16	44.63
CVN71 TEST 4	X	28.27	7.73
	Y	23.68	5.63
	Z	51.99	8.78

TABLE 2 - Maximum Responses of Seated Manikin During Tests 3 and 4 on CG53

GAGE LOCATION	MEASURE	DIRECTION	REFERENCE	TEST NO.	VALUE	
					UNFILT	60 HZ FILT
HEAD	ANGULAR ACC. rad/sec	RESULTANT XYZ	ABSOLUTE	3	4186.6	4188.7
				4	1830.9	1273.1
	ANGULAR VEL. rad/sec	"	"	3	1670.8	1670.8
				4	31.6	31.6
T_1	ACCELERATION g	Z	"	3	-14.7	-14.6
				4	10.3	10.4
	VELOCITY in/sec	"	"	3	-1651.5	-1651.5
				4	83.8	83.8
PELVIS	ACCELERATION g	Z	"	3	8.4	8.2
				4	12.3	12.4
	"	"	RELATIVE	3	15.7	16.2
				4	17.7	15.6
	VELOCITY in/sec	"	RELATIVE	3	132.4	132.4
				4	88.9	88.8
		"	"	3	96.5	97.7
				4	100.5	99.5
DECK	ACCELERATION g	"	ABSOLUTE	3	11.6	12.3
				4	-12.5	-12.2
	VELOCITY in/sec	"	"	3	171.9	173.2
				4	74.0	74.1

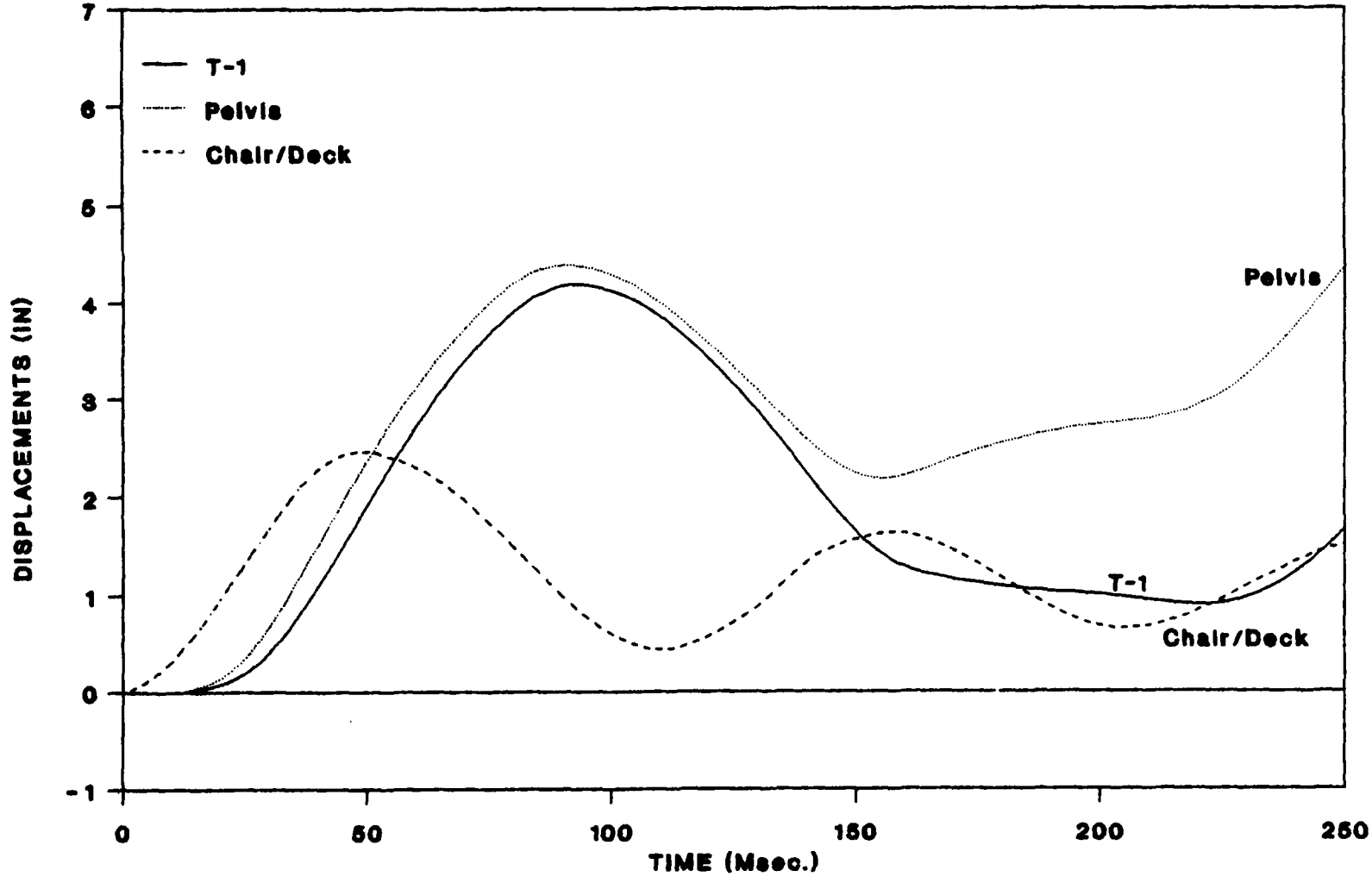

FIGURE 4 - **ABSOLUTE DISPLACEMENT ALONG Z FOR CG53-TEST#4 (FILTER 60 HZ)**

TABLE 3 - Maximum Responses of Standing Manikin and Deck During Tests 4 on CVN71

GAGE LOCATION	MEASURE	DIRECTION	REFERENCE	VALUE	
				UNFILT	60 HZ FILT
HEAD	ANGULAR ACC. rad/sec	RESULTANT XYZ	ABSOLUTE	809.1	641.0
	ANGULAR VEL. rad/sec	"	"	8.9	8.9
T_1	ACCELERATION g	Z	"	18.0	17.6
	VELOCITY in/sec	"	"	4.7	4.6
PELVIS	ACCELERATION g	Z	"	27.4	21.8
		"	RELATIVE	22.0	17.0
	VELOCITY in/sec	"	ABSOLUTE	4.3	4.3
		"	RELATIVE	4.7	4.7
DECK	ACCELERATION g	"	ABSOLUTE	15.7	15.1
	VELOCITY in/sec	"	"	4.4	4.3

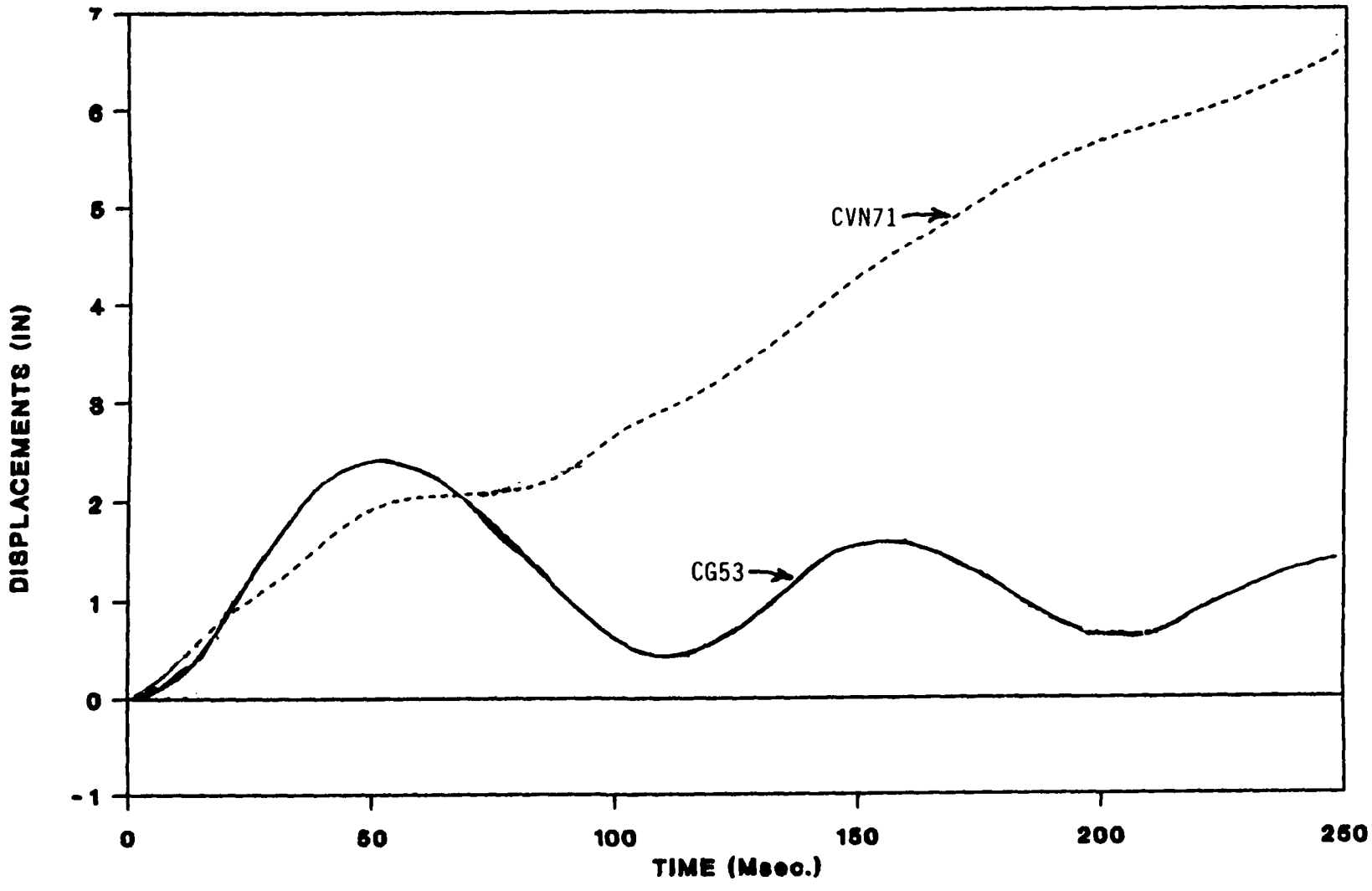

FIGURE 6 - COMPARISON OF ABSOLUTE DECK DISPLACEMENTS OF DECK ALONG Z DURING TEST 4 ON CG53 AND CVN71

the CG53 compared to 7.7 inches on the CVN71. Sway or lateral motion athwart ship (y) was also higher on the CVN71, 5.6 inches compared to 0.6 inches on the CG53.

Table 3, which tabulates the significant maximum responses measured at the various locations on the manikin during Shot 4, indicates that the head underwent small rotational acceleration, 600 to 800 radian/sec/sec. T-1 acceleration was also small, about 18 g and the pelvis acceleration was about 17 to 20 g. Figures 7, 8 and 9 show the absolute displacement of the manikin during the first 250 msec of the shock. Figure 10 indicates that the manikin (pelvis) left the deck in about 10 msec from the initiation of upward deck motion. Figure 7 shows that the manikin went into free flight rising to a maximum at about 125 msec and it was in free fall until about 210 msec ending in a somewhat prone position, as is evidenced by the forward (x) displacement of the pelvis and the relatively negative or backward motion of the T-1 seen in Figure 8.

6. DISCUSSION

Despite the relatively low levels of shock to which these two ships were exposed, several measures have appeared which, if not due to some anomaly associated with charge location standoff or deck configuration, may prove to be quite significant in the production of combat ineffectives, equipment damage, and in the design and operation of personnel protection equipment.

A 10 Hz high amplitude, long duration shock excitation, such as that observed on the deck in the CIC of the CG53, may have serious effects under live fire attack situations, if it is not included in design considerations for personnel seating, standing, and instrument shock mounting. Current shock protective seats [8,9] will isolate the occupant during an initial high amplitude shock directed upward through the seat base, and while it has instantaneous rearming capability, this capability was intended for protection against the explosion bubble pulse or successive attacks. It is unknown at this time whether the seat will provide protection against a rapidly applied series of hammer blows such as experienced by CIC room occupants and equipment. In that reference, the problem of protection may be more difficult to manage on the CVN71 where the longitudinal shock motions on the deck in the magazine were almost equal to the vertical. Should this motion be reliable and typical, then protection designed for the seated and standing occupant must be modified significantly to provide additional packaging in the x and y vectors corresponding to the seat orientation relative to the ship direction. Protective equipment consisting of crushable or pneumatic/hydraulic decking for standing man, will not manage ship motions in the x and y vectors.

The maximum levels of response experienced by the manikins on both ships were far short of injuries as can be seen on Figures 11 and 12 which are plots of tolerance levels for standing and seated men. [7] The situation is not as clear in regard to the head motions observed during Test 4, on the manikin seated in the CIC of CG53. The absolute angular acceleration was measured to be between about 1300 to 1800 radian/sec/sec.

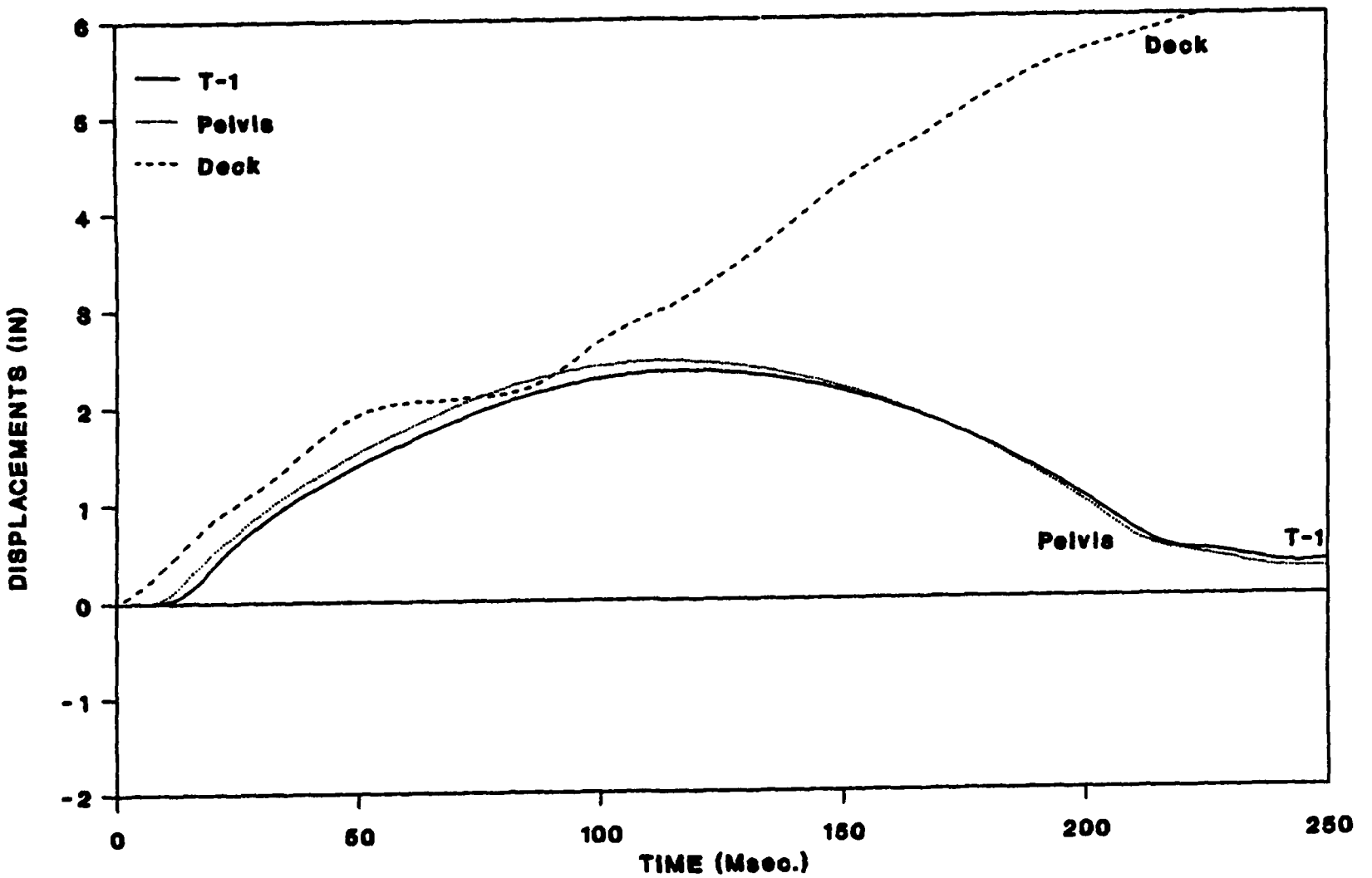

FIGURE 7 - **ABSOLUTE DISPLACEMENT ALONG Z FOR CVN71-TEST#4 (FILTER 60 HZ)**

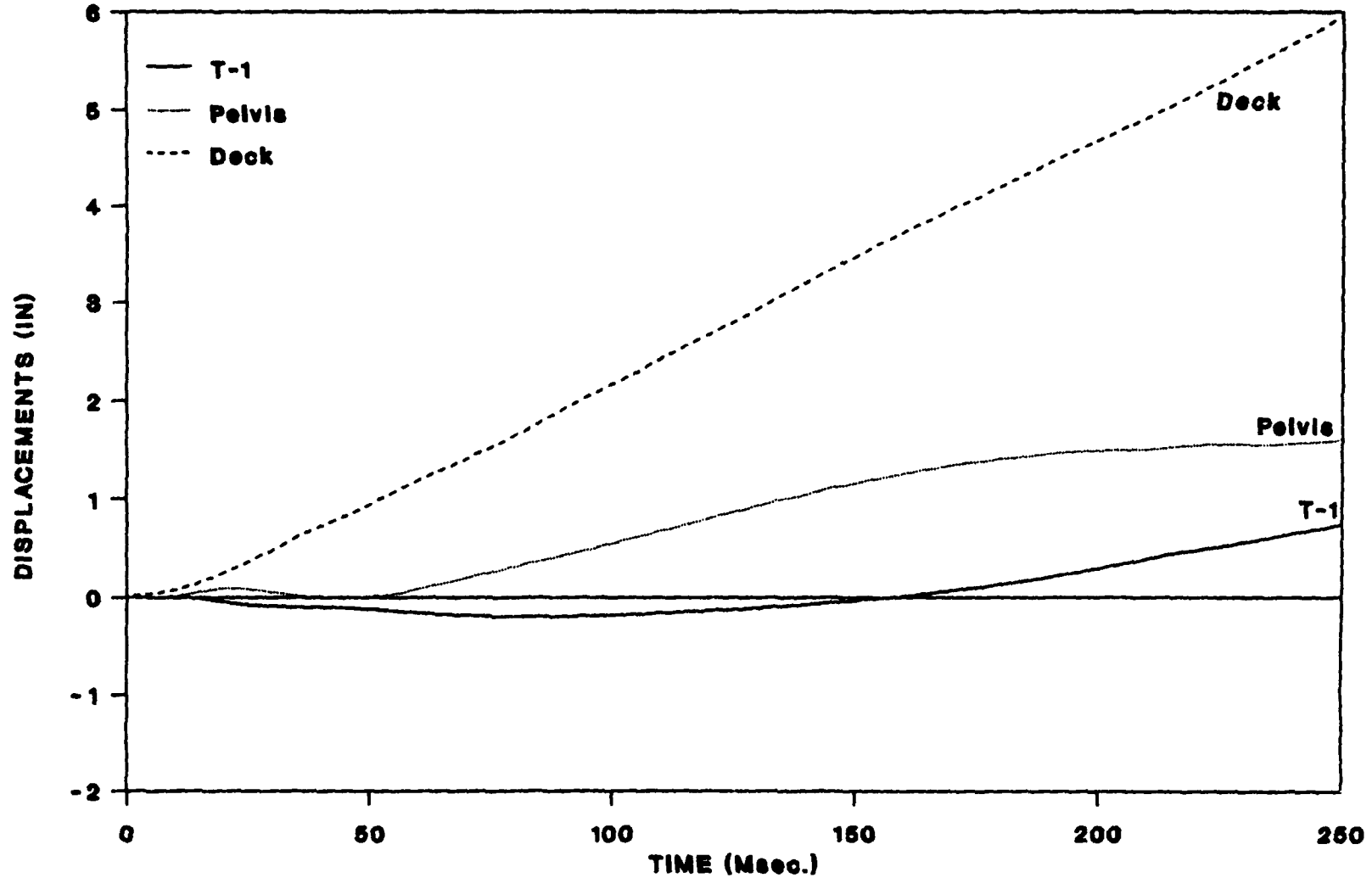

FIGURE 8 - **ABSOLUTE DISPLACEMENT ALONG X FOR CVN71-TEST#4 (FILTER 60 HZ)**

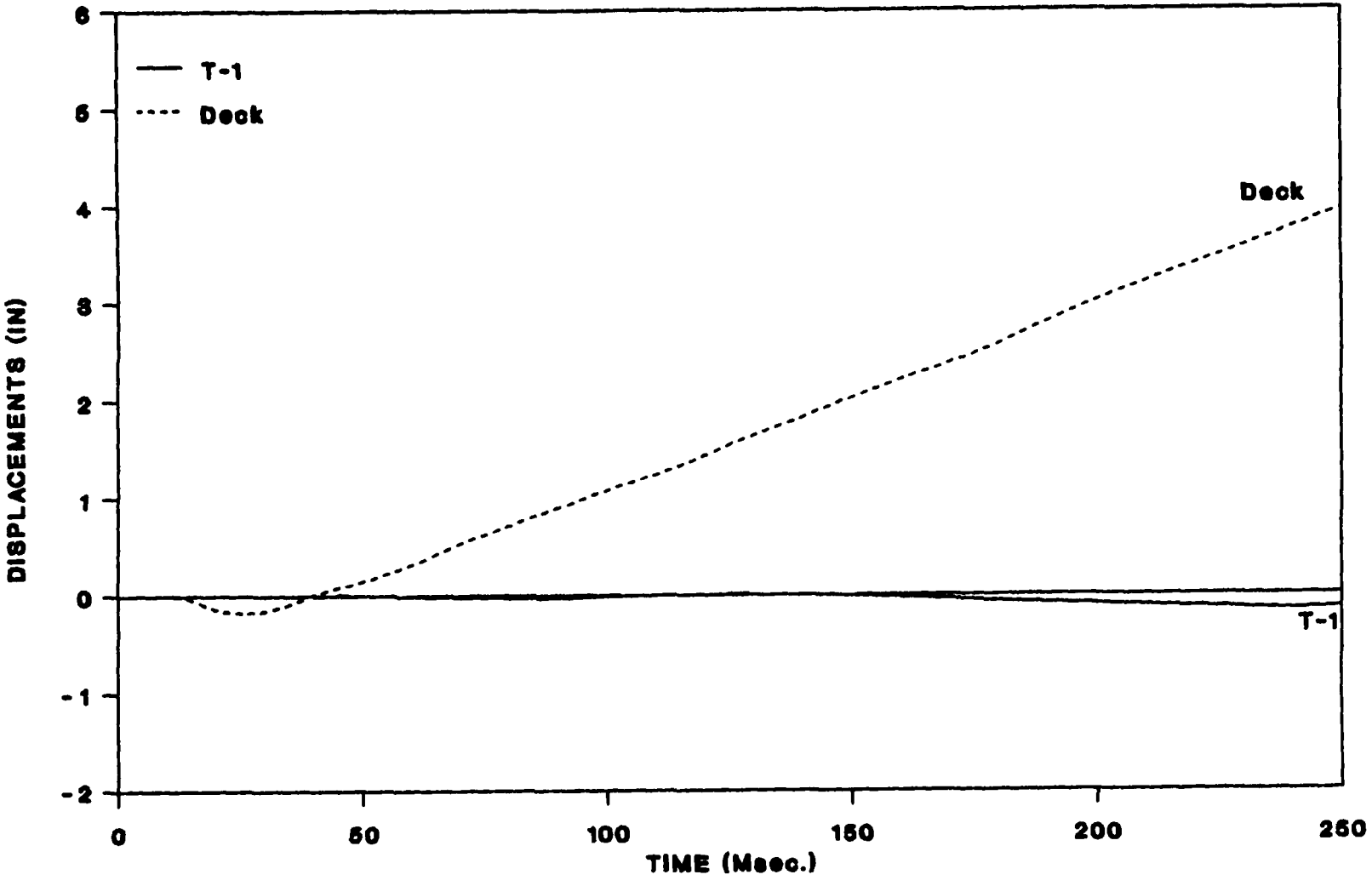

FIGURE 9 - **ABSOLUTE DISPLACEMENT ALONG Y FOR CVN71-TEST#4 (FILTER 60 HZ)**

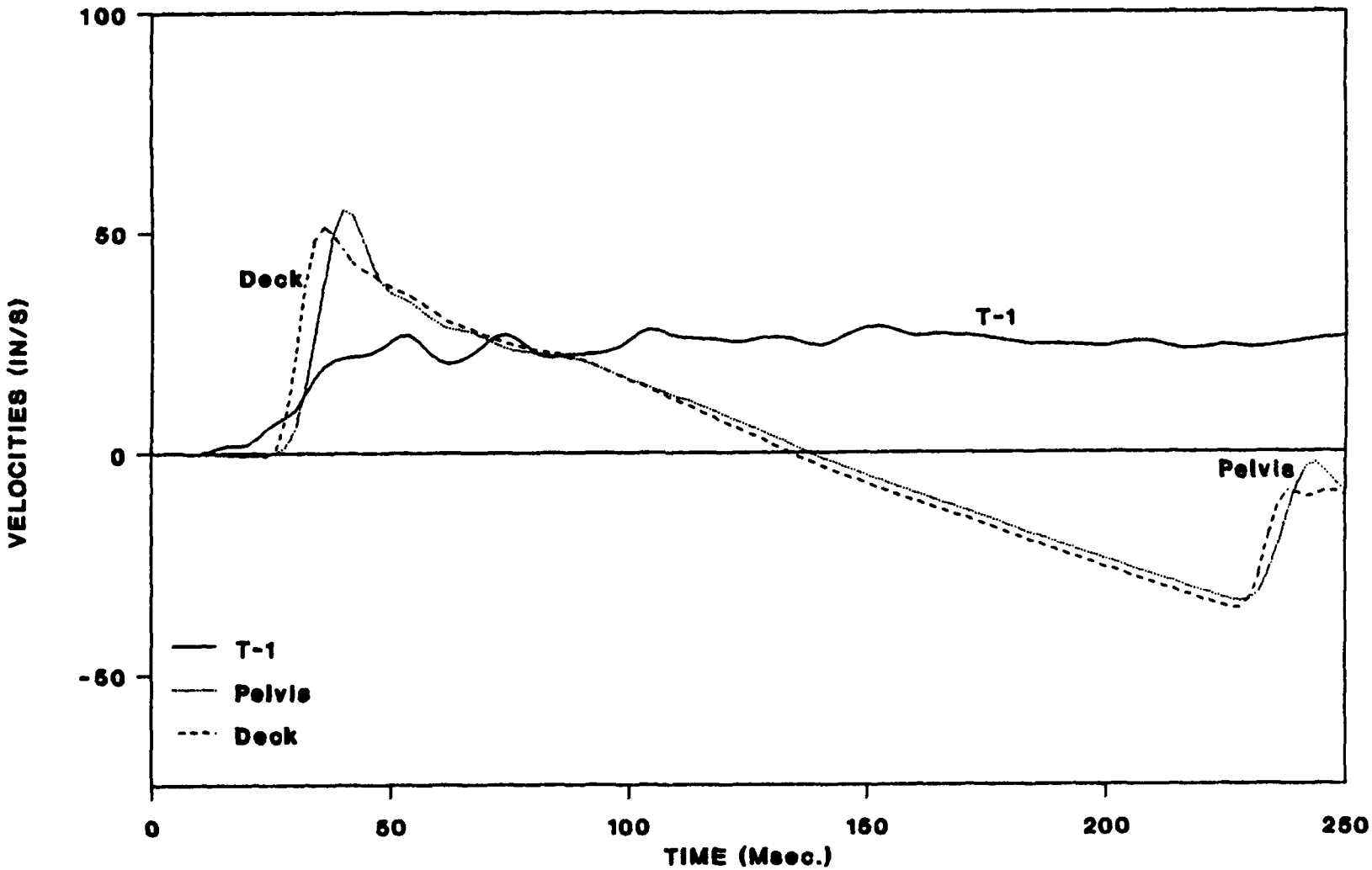

FIGURE 10 - **ABSOLUTE VELOCITIES ALONG Z FOR CVN71-TEST#4 (FILTER 60 HZ)**

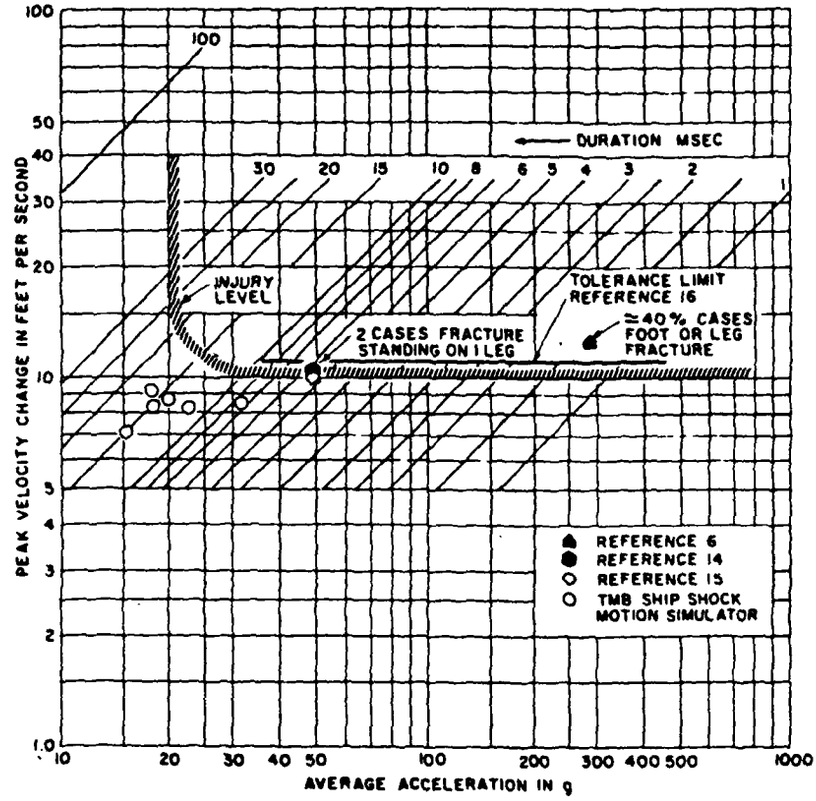

FIGURE 11 - Tolerance of stiff-legged standing men to shock motion of short duration. (From Reference 7)

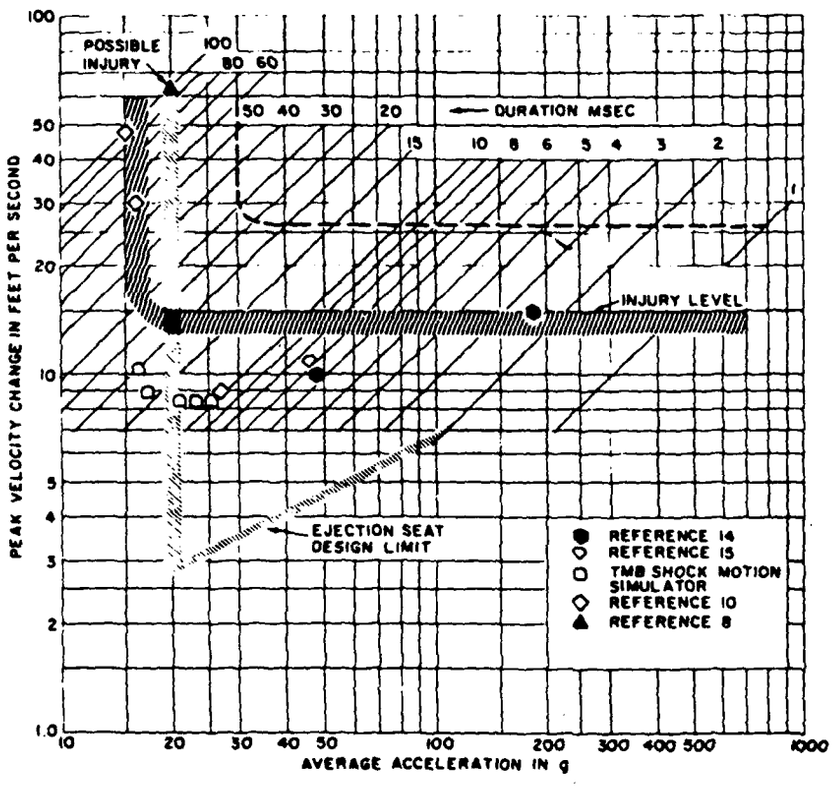

FIGURE 12 - Tolerance of seated men to shock motion of short duration. (From Reference 7)

Studies at NAVBIODYNLAB [11] show that the human head angular acceleration could be in excess of 50% greater than that measured on the Hybrid III. This would exceed NAVBIODYNLAB's measured safe limits [13] and suggests the possibility of potential brain concussion from whiplash (Figure 13). [12] There was no manikin present in the seated position on CVN 71; however, the x and y transverse motions are produced during Test 4, of 7.7 inches and 5.6 inches, indicate that large whiplash effects may be expected.

It can be seen that should the ship motions become more severe as they would in live fire situations there is considerable risk that without protective seats and decking properly tailored for the ship responses as observed in manned compartments during shock trials such as these, many unnecessary combat ineffectives could be produced.

7. CONCLUSIONS AND RECOMMENDATIONS

Participation in these trials has provided several insights, which may be of great value, if further verified by measures from future shock trials and full scale tests.

Current methods for prediction of combat ineffectives (CIs) produced by ship shock motion are based on an assumption that the response of a ship to a non-contact underwater attack is related to a computed shock factor which includes considerations of charge size, standoff and ship type. Implicit in the estimate of deck motion derived by this process, is the assumption of a standardized wave shape and direction of the deck motion, which is characterized as a single pulse directed upward. Other pulses resulting from bottom reflections or bubble pulses are neglected because of the differences in amplitude and time of occurrence.

The current series of shock trials has indicated that there is cause for concern that these assumptions for combat ineffective predictions may possibly lead to serious underestimation of the number of CIs and the importance to ship combat effectiveness. If validated, the appearance of large amplitude 10 Hz series of shock pulses in the CG53 CIC, and the large amplitude fore and aft components of shock motions appearing in the storage compartment on the CVN71, give warning that these responses may show, upon examination of shock records or subsequent ship trials, to be extensively distributed throughout the ship. Such a finding will require a modification of procedures for estimating CI production in addition to a revaluation of current shock protection design.

It is recommended therefore that these preliminary findings be seriously investigated and more detailed shock surveys conducted during future trials. A longer duration recording of shock motion which will permit the inclusion of a final steady state acceleration is imperative if valid assessment of zero drift or bias is to be made. In addition, ability to validate future data will also be considerably enhanced by the incorporation in the test instrumentation package, high speed cinematographic coverage which will permit displacement - time measures of the entire event thus providing an independent source of data for comparison with accelerometer derived displacement - time assessments.

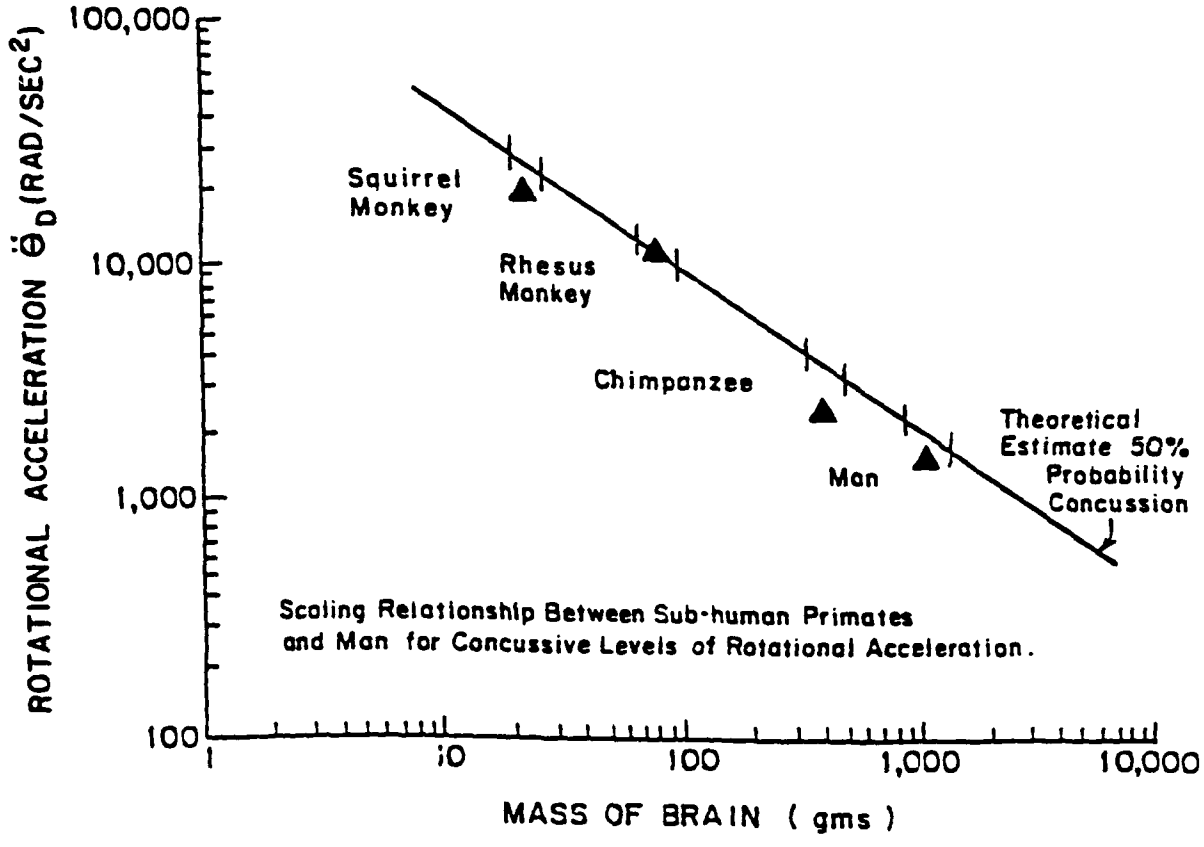

FIGURE 13 - Theoretical scaling of probability for onset of cerebral concussion in primates assuming that the crucial variable between species is mass of brain and that the crucial injury mechanism is severe shear strain imposed by brain rotation. (Reference 11)

Should further measures indicate that the vectors and amplitudes of deck responses observed in this study are pervasive throughout a ship and in a variety of ship types, then revision of predictive estimates for CI production and shock protection equipment concepts and design will clearly be indicated.

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APPENDIX A

Mobile Bay (CG53)

Test number : 1

Gauge location : Head (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	1.21	1.29	1.30	1.30	1.32	1.32
	y	-0.51	-0.57	-0.56	-0.56	-0.58	-0.59
	z	3.07	3.63	3.89	4.02	4.13	4.13
	res	3.08	3.70	3.96	4.11	4.21	4.21
Relative	x	1.66	2.36	3.10	3.51	3.63	3.63
	y	0.96	2.30	3.00	3.05	3.04	3.03
	z	7.17	7.89	8.23	8.34	8.57	8.58
	res	7.20	7.90	8.24	8.36	8.60	8.60
Velocity (in/s)							
Absolute	x	10.95	10.36	10.39	10.39	10.39	10.39
	y	3.31	3.42	3.44	3.44	3.45	3.45
	z	20.70	21.00	20.96	20.97	20.98	20.98
	res	21.31	21.66	21.62	21.63	21.64	21.64
Relative	x	9.95	9.76	9.90	9.93	9.93	9.93
	y	4.21	6.42	7.15	7.20	7.21	7.22
	z	39.39	40.45	40.47	40.42	40.41	40.41
	res	39.75	41.01	41.09	41.05	41.03	41.04
Displacement (in)							
Absolute	x	-0.64	-0.64	-0.64	-0.64	-0.64	-0.64
	y	0.35	0.35	0.35	0.35	0.35	0.35
	z	0.77	0.77	0.77	0.77	0.77	0.77
	res	0.87	0.88	0.87	0.88	0.88	0.88
Relative	x	0.57	0.58	0.58	0.58	0.58	0.59
	y	0.36	0.36	0.36	0.36	0.36	0.36
	z	0.73	0.74	0.74	0.74	0.74	0.74
	res	0.80	0.80	0.80	0.80	0.80	0.80

Mobile Bay (CG53)

Test number : 1

Gauge location : Head (angular)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (rad/s/s)							
Absolute	x	-97.78	169.38	238.02	263.99	280.03	278.91
	y	150.88	237.00	271.21	279.89	297.35	296.75
	z	-75.06	-101.14	-104.53	-106.04	-106.01	-105.93
	res	175.05	243.93	274.60	290.82	311.66	311.40
Velocity (rad/s)							
Absolute	x	-1.62	-1.97	-2.05	-2.06	-2.07	-2.07
	y	2.71	2.84	2.88	2.88	2.89	2.89
	z	1.05	1.16	1.16	1.16	1.16	1.16
	res	2.86	2.96	2.99	3.00	3.00	3.01
Displacement (rad)							
Absolute	x	-0.18	-0.18	-0.18	-0.18	-0.18	-0.18
	y	0.20	0.20	0.20	0.20	0.20	0.20
	z	0.08	0.08	0.08	0.08	0.08	0.08
	res	0.26	0.26	0.26	0.26	0.26	0.26

Mobile Bay (CG53)

Test number : 1

Gauge location : T-1 (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	0.77	1.12	1.33	1.36	1.40	1.40
	y	0.45	0.73	0.98	1.26	1.40	1.40
	z	3.26	3.64	3.81	3.87	3.90	3.90
	res	3.27	3.65	3.81	3.87	3.90	3.90
Relative	x	1.51	2.66	3.25	3.58	3.77	3.78
	y	1.12	2.32	3.03	3.08	3.07	3.07
	z	7.12	7.84	8.19	8.31	8.56	8.56
	res	7.17	7.86	8.22	8.37	8.63	8.63
Velocity (in/s)							
Absolute	x	-4.57	-4.79	-4.86	-4.87	-4.88	-4.88
	y	-2.40	-2.62	-2.72	-2.73	-2.72	-2.72
	z	21.12	21.41	21.38	21.38	21.38	21.37
	res	21.29	21.56	21.52	21.53	21.52	21.52
Relative	x	6.98	8.80	9.50	9.77	9.97	9.97
	y	4.32	6.50	7.23	7.27	7.28	7.28
	z	39.74	40.75	40.71	40.66	40.65	40.65
	res	40.13	41.35	41.36	41.33	41.31	41.31
Displacement (in)							
Absolute	x	-0.63	-0.63	-0.63	-0.63	-0.63	-0.63
	y	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
	z	0.83	0.83	0.83	0.83	0.83	0.83
	res	0.89	0.89	0.89	0.89	0.89	0.89
Relative	x	0.56	0.56	0.56	0.56	0.56	0.56
	y	0.09	0.10	0.10	0.10	0.10	0.10
	z	0.80	0.81	0.81	0.81	0.81	0.80
	res	0.80	0.81	0.81	0.81	0.81	0.81

Mobile Bay (CG53)

Test number : 1

Gauge location : Pelvis (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	2.42	2.52	2.72	2.78	2.83	2.83
	z	2.66	2.97	3.20	3.35	3.60	3.60
Relative	x	2.93	4.21	4.84	4.77	4.80	4.81
	z	6.69	7.38	7.75	7.91	8.15	8.15
Velocity (in/s)							
Absolute	x	-14.47	-14.73	-14.74	-14.74	-14.73	-14.73
	z	19.39	19.72	19.73	19.73	19.73	19.73
Relative	x	14.73	16.64	17.22	17.31	17.33	17.33
	z	38.97	39.87	39.84	39.81	39.80	39.80
Displacement (in)							
Absolute	x	-0.32	-0.32	-0.32	-0.32	-0.32	-0.32
	z	1.07	1.08	1.08	1.08	1.08	1.08
Relative	x	0.26	0.27	0.27	0.27	0.27	0.28
	z	0.95	0.96	0.96	0.96	0.96	0.96

Mobile Bay (CG53)

Test number : 1

Gauge location : Chair/deck (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	1.57	2.44	3.39	3.80	3.94	3.94
	y	1.02	-2.32	-3.02	-3.07	-3.06	-3.06
	z	4.94	5.60	6.01	6.23	6.51	6.51
	res	5.00	5.62	6.04	6.29	6.57	6.57
Velocity (in/s)							
Absolute	x	-7.2	-9.25	-10.32	-10.63	-10.72	-10.72
	y	-4.40	-6.58	-7.30	-7.35	-7.36	-7.36
	z	-25.45	-26.45	-26.60	-26.64	-26.65	-26.65
	res	25.56	26.70	26.91	26.99	27.01	27.01
Displacement (in)							
Absolute	x	-0.13	-0.14	-0.14	-0.14	-0.14	-0.14
	y	-0.07	-0.08	-0.08	-0.08	-0.08	-0.08
	z	0.68	0.68	0.68	0.68	0.68	0.68
	res	0.68	0.69	0.69	0.69	0.69	0.69

Mobile Bay (CG53)

Test number : 2

Gauge location : Head (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	3.07	3.47	3.58	3.58	3.58	3.57
	y	1.08	1.10	1.16	1.18	1.21	1.21
	z	4.62	5.52	5.83	5.81	5.77	5.77
	res	5.56	6.53	6.86	6.84	6.80	6.80
Relative	x	3.70	6.10	6.69	6.83	6.96	6.96
	y	1.29	2.12	2.73	2.95	3.02	3.02
	z	9.40	10.41	11.05	11.11	11.20	11.20
	res	9.58	10.61	11.25	11.27	11.35	11.35
Velocity (in/s)							
Absolute	x	22.08	22.12	22.16	22.16	22.17	22.17
	y	9.45	9.44	9.46	9.48	9.49	9.49
	z	37.00	37.16	37.11	37.10	37.09	37.09
	res	37.67	37.81	37.69	37.68	37.68	37.68
Relative	x	18.43	22.46	23.29	23.32	23.37	23.37
	y	10.77	11.44	11.61	11.74	11.84	11.84
	z	65.51	67.45	67.44	67.40	67.39	67.39
	res	65.54	67.48	67.45	67.40	67.40	67.40
Displacement (in)							
Absolute	x	1.16	1.17	1.17	1.17	1.17	1.17
	y	0.62	0.62	0.62	0.62	0.62	0.62
	z	1.53	1.54	1.54	1.54	1.54	1.54
	res	1.54	1.54	1.54	1.54	1.54	1.54
Relative	x	0.89	0.90	0.90	0.90	0.90	0.90
	y	0.67	0.67	0.67	0.67	0.67	0.67
	z	1.55	1.56	1.56	1.56	1.56	1.56
	res	1.55	1.56	1.57	1.57	1.57	1.57

Mobile Bay (CG53)

Test number : 2

Gauge location : Head (angular)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (rad/s/s)							
Absolute	x	-172.54	-185.51	-208.51	-263.02	-303.71	-302.12
	y	-336.56	-570.26	-869.52	-1093.70	-1304.80	-1306.34
	z	-91.42	-100.40	-111.83	-114.64	132.45	133.42
	res	340.65	580.90	895.10	1130.29	1342.69	1344.59
Velocity (rad/s)							
Absolute	x	-9.16	-9.09	-9.00	-8.95	-8.93	-8.92
	y	-12.73	-12.81	-12.82	-12.82	-12.82	-12.82
	z	-3.41	-3.37	-3.31	-3.28	-3.26	-3.25
	res	14.56	14.65	14.66	14.66	14.66	14.66
Displacement (rad)							
Absolute	x	-1.33	-1.33	-1.33	-1.33	-1.33	-1.33
	y	-1.95	-1.95	-1.95	-1.95	-1.95	-1.95
	z	-0.38	-0.38	-0.38	-0.38	-0.38	-0.38
	res	2.39	2.39	2.39	2.39	2.39	2.39

Mobile Bay (CG53)

Test number : 2

Gauge location : T-1 (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	0.98	1.34	1.59	1.74	1.86	1.86
	y	-0.46	0.64	0.92	1.09	1.20	1.20
	z	5.24	6.23	6.48	6.46	6.50	6.50
	res	5.27	6.30	6.55	6.53	6.57	6.56
Relative	x	2.06	5.01	6.36	6.98	7.38	7.36
	y	1.57	2.39	2.85	3.02	3.09	3.09
	z	9.61	10.34	10.77	10.84	10.90	10.89
	res	9.78	10.86	11.17	11.42	11.49	11.49
Velocity (in/s)							
Absolute	x	8.05	8.21	8.25	8.26	8.26	8.26
	y	4.44	4.50	4.62	4.67	4.68	4.68
	z	39.30	39.39	39.33	39.36	39.36	39.36
	res	39.77	39.86	39.80	39.83	39.84	39.84
Relative	x	13.19	14.37	14.97	15.31	15.49	15.49
	y	7.08	7.38	7.42	7.64	7.75	7.75
	z	65.98	67.65	67.51	67.44	67.44	67.44
	res	66.19	67.88	67.76	67.69	67.68	67.68
Displacement (in)							
Absolute	x	-0.55	-0.55	-0.55	-0.55	-0.55	-0.55
	y	0.30	0.30	0.30	0.30	0.30	0.30
	z	2.21	2.21	2.21	2.21	2.21	2.21
	res	2.23	2.23	2.23	2.23	2.23	2.23
Relative	x	0.60	0.61	0.61	0.61	0.61	0.61
	y	0.35	0.35	0.35	0.35	0.35	0.35
	z	2.42	2.43	2.43	2.43	2.43	2.43
	res	2.49	2.50	2.50	2.50	2.50	2.50

Mobile Bay (CG53)

Test number : 2

Gauge location : Pelvis (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	3.15	3.29	3.42	3.41	3.43	3.43
	z	4.94	6.00	6.10	6.10	6.14	6.14
Relative	x	4.46	7.70	8.42	8.59	8.71	8.71
	z	8.23	8.91	9.92	10.28	10.51	10.52
Velocity (in/s)							
Absolute	x	-26.17	-26.24	-26.21	-26.19	-26.19	-26.19
	z	34.63	34.88	34.66	34.71	34.73	34.73
Relative	x	24.38	27.08	27.53	27.63	27.68	27.68
	z	58.23	59.36	59.34	59.37	59.38	59.38
Displacement (in)							
Absolute	x	-0.73	-0.73	-0.73	-0.73	-0.73	-0.73
	z	2.39	2.39	2.39	2.39	2.39	2.39
Relative	x	0.69	0.70	0.70	0.70	0.70	0.70
	z	2.60	2.61	2.61	2.61	2.61	2.61

Mobile Bay (CG53)

Test number : 2

Gauge location : Chair/deck (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-2.19	-4.94	6.13	6.77	7.17	7.15
	y	1.54	2.41	3.02	3.25	3.32	3.32
	z	-6.72	-7.68	-8.36	-8.74	-9.00	-9.00
	res	6.83	7.85	8.52	8.83	9.06	9.06
Velocity (in/s)							
Absolute	x	7.68	-9.82	-11.51	-11.91	-12.08	-12.08
	y	5.11	6.22	6.87	6.95	6.96	6.96
	z	-34.80	-35.78	-36.02	-36.06	-36.08	-36.08
	res	34.95	35.94	36.16	36.20	36.20	36.20
Displacement (in)							
Absolute	x	0.33	0.33	0.34	0.34	0.34	0.34
	y	0.12	0.13	0.13	0.13	0.13	0.13
	z	0.95	0.97	0.97	0.97	0.97	0.97
	res	0.95	0.97	0.97	0.97	0.97	0.97

Mobile Bay (CG53)

Test number : 3

Gauge location : Head (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-6.43	-6.48	-6.58	-6.58	-6.59	-6.59
	y	2.93	2.99	3.15	3.20	3.23	3.23
	z	10.25	10.93	11.20	11.31	11.37	11.36
	res	10.90	11.50	11.68	11.76	11.82	11.81
Relative	x	7.43	8.79	10.15	11.48	12.23	12.25
	y	4.35	6.71	7.59	7.65	7.84	8.44
	z	14.44	15.36	15.92	16.25	16.45	16.45
	res	14.82	15.67	16.30	16.64	16.82	16.82
Velocity (in/s)							
Absolute	x	-653.49	-654.18	-654.10	-654.05	-654.01	-653.98
	y	341.55	341.63	341.61	341.62	341.63	341.64
	z	950.28	949.95	949.97	949.95	949.93	949.91
	res	1202.81	1202.94	1202.91	1202.87	1202.83	1202.81
Relative	x	604.09	603.07	602.74	602.89	603.16	603.26
	y	291.96	292.56	291.87	291.61	291.71	291.70
	z	779.59	776.76	776.82	777.18	777.65	777.97
	res	1028.55	1025.99	1025.63	1025.92	1026.47	1026.77
Displacement (in)							
Absolute	x	-158.64	-158.69	-158.69	-158.68	-158.68	-158.68
	y	82.75	82.74	82.74	82.74	82.74	82.74
	z	230.22	230.14	230.14	230.14	230.14	230.14
	res	291.58	291.53	291.53	291.53	291.53	291.53
Relative	x	146.93	147.12	147.11	147.08	147.01	146.95
	y	71.14	72.01	71.77	71.62	71.50	71.41
	z	185.84	185.38	185.51	185.64	185.78	185.89
	res	247.36	247.38	247.40	247.43	247.46	247.49

Mobile Bay (CG53)

Test number : 3

Gauge location : Head (angular)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (rad/s/s)							
Absolute	x	482.09	560.89	644.92	663.27	687.90	687.14
	y	3997.79	4119.50	4147.30	4142.64	4142.77	4143.33
	z	-709.41	-739.83	-753.46	-756.21	-758.26	-757.11
	res	4044.22	4162.49	4188.67	4183.86	4183.98	4184.55
Velocity (rad/s)							
Absolute	x	161.25	161.21	161.22	161.24	161.26	161.27
	y	1644.67	1644.78	1644.87	1644.90	1644.91	1644.91
	z	-244.50	-244.54	-244.57	-244.58	-244.57	-244.57
	res	1670.55	1670.65	1670.75	1670.78	1670.79	1670.79
Displacement (rad)							
Absolute	x	38.91	38.91	38.91	38.91	38.91	38.91
	y	399.13	399.13	399.13	399.13	399.13	399.13
	z	-59.34	-59.34	-59.34	-59.34	-59.34	-59.34
	res	405.39	405.39	405.39	405.39	405.39	405.39

Mobile Bay (CG53)

Test number : 3

Gauge location : T-1 (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-2.02	-2.23	-2.30	-2.34	-2.37	-2.37
	y	3.19	3.80	4.24	4.32	4.37	4.37
	z	-14.21	-14.31	-14.55	-14.72	-14.74	-14.74
	res	14.49	14.56	14.80	15.02	15.09	15.08
Relative	x	3.22	5.07	7.74	9.23	10.03	10.05
	y	4.57	6.90	7.79	7.85	8.03	8.36
	z	24.33	25.58	26.03	26.62	27.05	27.04
	res	24.67	26.10	26.34	26.98	27.73	27.74
Velocity (in/s)							
Absolute	x	-74.76	-74.18	-74.19	-74.20	-74.22	-74.23
	y	370.67	370.87	370.95	370.96	370.96	370.97
	z	-1650.98	-1651.51	-1651.50	-1651.50	-1651.50	-1651.50
	res	1693.73	1694.27	1694.27	1694.27	1694.27	1694.28
Relative	x	32.45	34.72	35.15	35.08	34.91	34.80
	y	321.08	321.80	321.21	320.94	321.04	321.03
	z	1821.68	1824.70	1824.66	1824.28	1823.77	1823.44
	res	1849.93	1853.00	1852.86	1852.44	1851.96	1851.63
Displacement (in)							
Absolute	x	-18.96	-18.93	-18.93	-18.93	-18.93	-18.93
	y	90.65	90.65	90.65	90.65	90.65	90.65
	z	-400.38	-400.51	-400.51	-400.51	-400.51	-400.51
	res	410.96	411.08	411.08	411.08	411.07	411.07
Relative	x	7.25	7.36	7.35	7.32	7.25	7.20
	y	79.04	79.91	79.68	79.53	79.41	79.32
	z	444.76	445.27	445.14	445.01	444.87	444.76
	res	451.79	452.44	452.27	452.12	451.96	451.83

Mobile Bay (CG53)

Test number : 3

Gauge location : Pelvis (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-4.43	-5.52	-6.39	-6.86	-7.32	-7.31
	z	6.53	7.81	8.16	8.28	8.35	8.35
Relative	x	5.34	6.96	8.09	9.17	9.47	9.47
	z	14.08	15.46	15.71	15.99	16.15	16.15
Velocity (in/s)							
Absolute	x	-114.10	-114.73	-114.82	-114.82	-114.84	-114.85
	z	132.93	132.38	132.40	132.40	132.40	132.41
Relative	x	68.93	70.15	70.15	70.10	69.95	69.83
	z	93.74	96.88	97.38	97.11	96.77	96.54
Displacement (in)							
Absolute	x	-27.31	-27.41	-27.42	-27.41	-27.41	-27.41
	z	32.79	32.57	32.57	32.57	32.57	32.57
Relative	x	15.60	15.85	15.84	15.81	15.73	15.67
	z	11.59	12.18	12.06	11.94	11.79	11.68

Mobile Bay (CG53)

Test number : 3

Gauge location : Chair/deck (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-2.91	-4.84	7.25	8.70	9.55	9.57
	y	-2.55	-4.90	-5.78	-5.84	-6.02	-6.90
	z	10.23	11.29	11.55	11.95	12.32	12.32
	res	10.55	12.13	12.85	13.63	14.43	14.45
Velocity (in/s)							
Absolute	x	-49.40	-51.11	-51.36	-51.16	-51.13	-51.25
	y	49.59	49.07	49.75	50.01	49.93	49.95
	z	170.70	173.19	173.16	172.78	172.27	171.94
	res	184.49	187.12	187.34	187.00	186.43	186.09
Displacement (in)							
Absolute	x	-11.71	-11.57	-11.58	-11.61	-11.68	-11.73
	y	11.61	10.74	10.98	11.12	11.24	11.33
	z	44.38	44.75	44.63	44.51	44.36	44.25
	res	47.35	47.46	47.39	47.32	47.23	47.16

Mobile Bay (CG53)

Test number : 4

Gauge location : Head (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	5.56	5.99	6.14	6.17	6.18	6.18
	y	-1.06	-1.15	-1.17	-1.19	-1.22	-1.22
	z	-7.52	8.48	8.72	8.88	9.02	9.02
	res	8.13	9.25	9.48	9.61	9.73	9.73
Relative	x	6.07	7.24	8.72	9.00	9.86	9.86
	y	1.99	3.46	4.85	5.80	6.36	6.37
	z	14.95	16.53	17.54	17.77	17.87	17.86
	res	15.32	16.86	17.79	17.93	17.95	17.96
Velocity (in/s)							
Absolute	x	57.30	56.45	56.15	56.11	56.06	56.04
	y	-8.21	-8.32	-8.32	-8.33	-8.33	-8.33
	z	-81.68	-83.24	-83.20	-83.20	-83.20	-83.20
	res	87.04	88.09	88.08	88.10	88.10	88.10
Relative	x	61.38	60.29	59.23	59.07	58.98	58.97
	y	15.62	17.12	17.59	17.63	17.69	17.69
	z	119.99	125.35	128.42	129.31	129.58	129.58
	res	124.67	129.70	132.83	133.70	133.95	133.95
Displacement (in)							
Absolute	x	4.78	4.78	4.78	4.78	4.78	4.78
	y	-0.95	-0.95	-0.95	-0.95	-0.95	-0.95
	z	-5.32	-5.32	-5.32	-5.33	-5.32	-5.32
	res	7.21	7.22	7.22	7.22	7.22	7.22
Relative	x	5.64	5.63	5.63	5.63	5.63	5.63
	y	0.85	0.84	0.84	0.84	0.84	0.84
	z	6.26	6.26	6.27	6.27	6.27	6.27
	res	8.46	8.47	8.47	8.47	8.47	8.47

Mobile Bay (CG53)

Test number : 4

Gauge location : Head (angular)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (rad/s/s)							
Absolute	x	-263.29	-419.21	-559.60	-622.06	-622.65	-622.25
	y	-626.99	-747.76	-1157.31	-1498.98	-1712.15	-1713.54
	z	-185.53	-201.01	-225.42	-246.61	-253.44	-254.48
	res	629.71	768.13	1273.10	1607.35	1829.65	1830.93
Velocity (rad/s)							
Absolute	x	-14.45	-14.52	-14.55	-14.56	-14.55	-14.55
	y	-27.86	-28.39	-28.47	-28.48	-28.47	-28.47
	z	-7.03	-7.09	-7.10	-7.10	-7.10	-7.10
	res	30.94	31.50	31.60	31.61	31.61	31.61
Displacement (rad)							
Absolute	x	-3.72	-3.72	-3.72	-3.72	-3.72	-3.72
	y	-4.86	-4.86	-4.87	-4.87	-4.86	-4.86
	z	-1.42	-1.42	-1.42	-1.42	-1.42	-1.42
	res	6.29	6.29	6.29	6.29	6.29	6.29

Mobile Bay (CG53)

Test number : 4

Gauge location : T-1 (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-2.36	-2.82	-2.83	-2.81	-2.84	-2.84
	y	-0.97	-1.28	-1.96	-2.24	-2.22	-2.23
	z	8.67	10.15	10.43	10.36	10.32	10.32
	res	8.98	10.53	10.79	10.74	10.70	10.70
Relative	x	2.82	6.55	9.94	11.03	11.77	11.77
	y	2.54	3.93	5.19	5.65	5.82	5.80
	z	14.60	15.23	16.00	16.33	16.38	16.38
	res	14.78	15.58	18.18	18.82	19.48	19.48
Velocity (in/s)							
Absolute	x	25.73	25.83	25.88	25.89	25.89	25.89
	y	-8.98	-9.27	-9.43	-9.51	-9.54	-9.54
	z	83.60	83.89	83.79	83.78	83.79	83.79
	res	86.72	86.87	86.62	86.59	86.59	86.59
Relative	x	28.65	29.14	29.25	29.26	29.27	29.27
	y	17.68	18.76	19.12	19.22	19.22	19.22
	z	103.94	109.33	112.42	113.33	113.61	113.61
	res	105.46	109.70	112.72	113.62	113.91	113.91
Displacement (in)							
Absolute	x	-1.29	-1.29	-1.29	-1.29	-1.29	-1.29
	y	-0.98	-0.98	-0.98	-0.98	-0.98	-0.98
	z	4.36	4.36	4.36	4.36	4.35	4.35
	res	4.49	4.48	4.48	4.48	4.48	4.48
Relative	x	1.67	1.67	1.67	1.67	1.67	1.66
	y	0.98	0.98	0.98	0.98	0.98	0.98
	z	3.53	3.54	3.54	3.54	3.54	3.54
	res	3.85	3.84	3.84	3.84	3.84	3.84

Mobile Bay (CG53)

Test number : 4

Gauge location : Pelvis (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	3.51	-4.17	-4.64	-5.70	-7.51	-7.56
	z	10.00	12.12	12.38	12.32	12.33	12.34
Relative	x	5.12	9.87	13.21	14.12	14.69	14.68
	z	13.41	14.12	15.59	17.03	17.68	17.68
Velocity (in/s)							
Absolute	x	29.04	28.94	28.94	28.95	28.95	28.95
	z	87.07	88.79	88.84	88.85	88.86	88.86
Relative	x	33.35	34.84	35.86	36.07	36.12	36.12
	z	97.88	97.18	99.53	100.34	100.48	100.48
Displacement (in)							
Absolute	x	2.93	2.93	2.93	2.93	2.93	2.93
	z	7.32	7.31	7.31	7.31	7.31	7.31
Relative	x	3.79	3.78	3.78	3.78	3.78	3.78
	z	6.38	6.37	6.37	6.37	6.37	6.37

Mobile Bay (CG53)

Test number : 4

Gauge location : Chair/deck (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-1.61	-5.88	-9.12	-10.18	-10.88	-10.88
	y	-2.13	-3.48	-4.82	-5.30	5.71	5.73
	z	-10.41	-12.14	-12.23	-12.23	-12.46	-12.45
	res	10.55	12.24	12.40	13.25	13.83	13.83
Velocity (in/s)							
Absolute	x	-8.87	9.47	11.64	11.90	12.01	12.01
	y	13.32	14.84	15.41	15.49	15.44	15.45
	z	73.64	74.23	73.97	74.02	74.06	74.06
	res	73.65	74.28	74.04	74.09	74.13	74.13
Displacement (in)							
Absolute	x	-0.85	-0.85	-0.85	-0.85	-0.85	-0.85
	y	0.58	0.57	0.57	0.57	0.57	0.57
	z	2.45	2.46	2.46	2.46	2.46	2.46
	res	2.48	2.49	2.49	2.49	2.49	2.49

APPENDIX B

Roosevelt (CVN71)

Test number : 2

Gauge location : Head (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	1.97	2.87	3.42	3.58	3.62	3.62
	y	-1.40	-1.52	-1.59	-1.60	-1.61	-1.60
	z	3.17	5.64	7.76	8.57	8.78	8.78
	res	3.79	6.42	8.58	9.40	9.60	9.61
Relative	x	2.02	3.32	4.20	4.41	4.49	4.49
	y	2.62	3.75	4.38	5.42	5.72	5.71
	z	4.35	9.28	12.06	12.59	13.09	13.08
	res	4.41	9.37	12.40	12.87	13.21	13.20
Velocity (in/s)							
Absolute	x	-11.67	-11.42	-11.38	-11.38	-11.38	-11.38
	y	-9.36	-9.52	-9.55	-9.56	-9.56	-9.56
	z	19.17	22.58	24.45	24.87	24.99	24.99
	res	20.89	24.64	26.51	26.92	27.05	27.05
Relative	x	23.55	23.57	23.72	23.84	23.92	23.92
	y	20.92	21.18	21.32	21.37	21.37	21.37
	z	30.42	34.19	35.21	35.32	35.39	35.39
	res	43.36	45.70	45.95	45.79	45.75	45.75
Displacement (in)							
Absolute	x	-0.44	-0.43	-0.43	-0.43	-0.43	-0.43
	y	-0.26	-0.26	-0.27	-0.26	-0.26	-0.26
	z	0.72	0.72	0.73	0.73	0.73	0.73
	res	0.76	0.76	0.76	0.76	0.76	0.76
Relative	x	2.95	2.95	2.94	2.94	2.95	2.95
	y	3.09	3.08	3.08	3.08	3.08	3.08
	z	3.09	3.09	3.09	3.09	3.09	3.09
	res	5.27	5.27	5.27	5.27	5.27	5.27

Roosevelt (CVN71)

Test number : 2

Gauge location : Head (angular)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (rad/s/s)							
Absolute	x	165.31	-287.95	-403.04	-435.28	-437.88	-439.21
	y	189.75	-248.53	-296.60	-310.56	-314.08	-314.76
	z	-49.06	-98.13	-144.67	-153.58	-153.97	-154.26
	res	246.85	338.59	472.54	521.13	528.14	529.35
Velocity (rad/s)							
Absolute	x	-2.56	-2.83	-2.93	-2.96	-2.96	-2.96
	y	-5.04	-5.26	-5.29	-5.29	-5.29	-5.28
	z	-1.17	-1.16	-1.18	-1.18	-1.18	-1.18
	res	5.57	5.75	5.77	5.77	5.77	5.77
Displacement (rad)							
Absolute	x	-0.10	-0.10	-0.10	-0.10	-0.10	-0.10
	y	-0.39	-0.39	-0.39	-0.39	-0.39	-0.39
	z	-0.13	-0.13	-0.13	-0.13	-0.13	-0.13
	res	0.42	0.42	0.42	0.42	0.42	0.42

Roosevelt (CVN71)

Test number : 2

Gauge location : T-1 (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-0.53	-1.16	-1.55	-1.63	-1.67	-1.66
	y	-0.65	-0.96	-1.22	-1.40	-1.50	-1.51
	z	3.70	6.51	8.43	8.79	8.81	8.82
	res	3.78	6.65	8.60	8.96	8.98	8.99
Relative	x	2.02	3.35	4.73	5.54	6.14	6.15
	y	2.68	3.61	4.42	5.47	5.77	5.77
	z	4.33	9.21	11.39	11.98	12.57	12.56
	res	4.99	9.70	11.77	12.26	12.95	12.95
Velocity (in/s)							
Absolute	x	4.07	4.19	4.25	4.25	4.25	4.25
	y	-5.01	-5.20	-5.25	-5.29	-5.32	-5.32
	z	21.50	25.59	27.54	27.87	27.95	27.95
	res	21.68	25.86	27.87	28.20	28.28	28.28
Relative	x	13.93	14.84	15.27	15.24	15.29	15.29
	y	18.44	18.73	18.91	18.98	19.02	19.02
	z	30.49	33.32	34.49	34.65	34.75	34.75
	res	34.84	37.82	38.95	39.08	39.16	39.16
Displacement (in)							
Absolute	x	0.14	0.14	0.14	0.14	0.14	0.14
	y	-0.48	-0.48	-0.48	-0.48	-0.48	-0.48
	z	0.77	0.77	0.77	0.77	0.77	0.77
	res	0.78	0.79	0.79	0.78	0.78	0.78
Relative	x	2.37	2.37	2.37	2.37	2.37	2.37
	y	3.31	3.30	3.30	3.30	3.30	3.30
	z	2.91	2.90	2.91	2.91	2.91	2.91
	res	5.00	5.00	5.00	5.00	5.00	5.00

Roosevelt (CVN71)

Test number : 2

Gauge location : Pelvis (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-0.80	-1.59	2.45	2.94	3.62	3.64
	z	3.51	6.23	9.68	11.57	12.38	12.35
Relative	x	1.58	1.86	2.28	2.60	3.34	3.33
	z	3.96	6.69	8.83	10.49	11.34	11.32
Velocity (in/s)							
Absolute	x	8.06	8.56	8.82	8.90	8.97	8.97
	z	20.38	22.77	23.20	23.21	23.27	23.27
Relative	x	13.47	14.84	15.20	15.27	15.33	15.33
	z	30.14	32.90	33.02	33.01	33.05	33.05
Displacement (in)							
Absolute	x	0.71	0.71	0.71	0.71	0.71	0.71
	z	0.78	0.78	0.78	0.78	0.78	0.78
Relative	x	1.80	1.80	1.80	1.80	1.80	1.80
	z	2.73	2.73	2.73	2.73	2.73	2.73

Roosevelt (CVN71)

Test number : 2

Gauge location : Chair/deck (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	1.52	2.37	3.58	4.41	5.08	5.07
	y	2.63	3.67	-4.37	-5.41	-5.71	-5.70
	z	3.76	6.60	8.83	9.91	10.86	10.91
	res	4.41	7.35	9.36	10.25	11.08	11.12
Velocity (in/s)							
Absolute	x	13.31	13.78	13.99	14.05	14.09	14.08
	y	14.72	15.09	15.47	15.62	15.66	15.66
	z	23.32	26.33	26.55	26.82	26.91	26.91
	res	29.18	31.66	32.04	32.20	32.22	32.22
Displacement (in)							
Absolute	x	2.51	2.51	2.51	2.51	2.51	2.51
	y	2.83	2.83	2.83	2.83	2.83	2.83
	z	2.94	2.94	2.94	2.94	2.94	2.94
	res	4.79	4.79	4.79	4.79	4.79	4.79

Roosevelt (CVN71)

Test number : 3

Gauge location : Head (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	2.27	3.42	4.05	4.14	4.16	4.16
	y	-0.85	-0.98	-1.00	-1.00	-0.99	-0.99
	z	4.25	7.43	9.61	10.32	10.71	10.71
	res	4.72	8.13	10.41	11.10	11.46	11.46
Relative	x	2.14	3.20	3.91	4.23	4.77	4.77
	y	3.13	4.90	6.49	7.97	8.08	8.07
	z	5.25	11.27	14.59	14.85	15.45	15.46
	res	5.43	11.58	15.27	15.39	15.68	15.69
Velocity (in/s)							
Absolute	x	26.01	24.92	24.65	24.60	24.54	24.51
	y	5.76	5.98	6.08	6.10	6.10	6.10
	z	26.21	29.94	31.69	31.95	32.02	32.02
	res	29.34	33.28	34.82	35.09	35.17	35.17
Relative	x	35.10	35.12	35.33	35.50	35.56	35.56
	y	18.25	18.57	18.58	18.69	18.73	18.73
	z	46.57	46.70	46.58	46.73	46.83	46.83
	res	57.48	56.74	56.86	56.94	56.94	56.94
Displacement (in)							
Absolute	x	-0.83	-0.84	-0.84	-0.84	-0.84	-0.84
	y	-0.25	-0.26	-0.26	-0.26	-0.26	-0.26
	z	1.24	1.23	1.23	1.23	1.23	1.23
	res	1.27	1.27	1.27	1.28	1.28	1.28
Relative	x	4.19	4.19	4.19	4.19	4.20	4.20
	y	3.27	3.27	3.27	3.27	3.27	3.27
	z	6.09	6.09	6.09	6.09	6.09	6.09
	res	8.02	8.03	8.03	8.03	8.03	8.03

Roosevelt (CVN71)

Test number : 3

Gauge location : Head (angular)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (rad/s/s)							
Absolute	x	-142.55	-258.36	-341.84	-373.96	-386.88	-386.13
	y	-265.80	-403.96	-422.70	-420.19	-417.75	-417.52
	z	-41.73	-58.20	-86.52	-90.83	-91.52	-92.47
	res	297.70	480.40	541.61	561.39	572.48	571.76
Velocity (rad/s)							
Absolute	x	3.73	3.81	3.86	3.87	3.88	3.88
	y	-11.34	-11.43	-11.48	-11.49	-11.49	-11.49
	z	-0.83	-0.84	-0.87	-0.88	-0.88	-0.88
	res	11.52	11.62	11.56	11.57	11.57	11.57
Displacement (rad)							
Absolute	x	0.40	0.40	0.40	0.40	0.40	0.40
	y	-1.74	-1.74	-1.74	-1.74	-1.73	-1.73
	z	-0.11	-0.11	-0.11	-0.11	-0.11	-0.11
	res	1.78	1.79	1.79	1.79	1.78	1.78

Roosevelt (CVN71)

Test number : 3

Gauge location : T-1 (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-0.62	-1.26	-1.76	-1.93	-2.04	-2.05
	y	-0.39	-0.80	-1.15	-1.31	-1.70	-1.70
	z	5.23	9.28	11.88	12.27	12.31	12.30
	res	5.27	9.37	12.01	12.38	12.42	12.41
Relative	x	2.42	3.12	3.81	4.33	5.03	5.04
	y	2.96	4.58	6.49	7.97	8.07	8.07
	z	5.57	11.98	14.94	15.21	15.78	15.79
	res	5.99	12.23	15.19	15.56	16.26	16.27
Velocity (in/s)							
Absolute	x	18.74	18.89	18.99	18.99	18.99	18.99
	y	-4.25	-3.97	-3.98	-3.97	-4.08	-4.07
	z	31.56	36.70	38.96	39.32	39.34	39.34
	res	31.72	36.98	39.33	39.70	39.73	39.72
Relative	x	20.02	20.69	21.10	21.14	21.06	21.06
	y	14.99	15.05	15.65	15.80	15.86	15.86
	z	44.95	44.79	44.43	44.48	44.55	44.55
	res	47.72	47.59	47.28	47.36	47.42	47.42
Displacement (in)							
Absolute	x	2.19	2.19	2.20	2.20	2.20	2.20
	y	-0.46	-0.46	-0.46	-0.46	-0.45	-0.45
	z	1.39	1.39	1.39	1.39	1.39	1.39
	res	2.33	2.33	2.33	2.33	2.33	2.33
Relative	x	2.64	2.64	2.64	2.64	2.64	2.64
	y	3.47	3.47	3.47	3.47	3.47	3.47
	z	4.86	4.86	4.86	4.86	4.86	4.86
	res	6.50	6.51	6.51	6.51	6.51	6.51

Roosevelt (CVN71)

Test number : 3

Gauge location : Pelvis (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	1.51	-2.83	-3.78	-4.33	-4.85	-4.85
	z	4.91	8.85	13.34	15.59	16.45	16.47
Relative	x	2.10	3.20	4.26	4.60	5.18	5.18
	z	5.21	8.83	12.76	14.14	15.42	15.35
Velocity (in/s)							
Absolute	x	9.48	9.56	9.57	9.58	9.58	9.58
	z	30.27	32.66	32.92	32.75	32.61	32.61
Relative	x	21.27	23.57	24.17	24.11	24.08	24.08
	z	44.95	44.99	44.81	44.86	44.94	44.94
Displacement (in)							
Absolute	x	1.41	1.41	1.41	1.41	1.41	1.41
	z	1.41	1.41	1.41	1.41	1.41	1.41
Relative	x	3.37	3.37	3.37	3.37	3.37	3.37
	z	5.09	5.09	5.09	5.09	5.09	5.09

Roosevelt (CVN71)

Test number : 3

Gauge location : Chair/deck (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	1.89	2.29	3.17	4.03	4.72	4.71
	y	3.11	4.76	-6.49	-7.97	-8.07	-8.07
	z	5.68	9.47	12.78	14.27	14.59	14.51
	res	6.41	10.41	13.49	14.80	15.09	15.16
Velocity (in/s)							
Absolute	x	18.23	18.59	18.81	18.88	18.89	18.89
	y	13.55	14.04	15.51	15.82	15.81	15.81
	z	34.82	40.03	40.83	40.79	40.76	40.76
	res	38.74	43.87	45.42	45.67	45.77	45.77
Displacement (in)							
Absolute	x	4.78	4.78	4.78	4.78	4.78	4.78
	y	3.01	3.01	3.01	3.01	3.01	3.01
	z	5.51	5.51	5.51	5.51	5.51	5.51
	res	7.89	7.89	7.89	7.89	7.89	7.89

Roosevelt (CVN71)

Test number : 4

Gauge location : Head (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	2.87	4.67	5.50	5.52	5.47	5.47
	y	0.71	0.84	0.97	1.00	1.01	1.01
	z	5.99	11.03	14.23	14.88	15.03	15.03
	res	6.62	11.91	15.15	15.80	15.96	15.96
Relative	x	2.68	3.30	4.57	4.79	5.22	5.21
	y	4.10	6.35	10.76	13.53	14.38	14.37
	z	6.27	15.09	20.33	20.59	21.03	21.05
	res	6.66	15.33	20.86	21.06	21.34	21.36
Velocity (in/s)							
Absolute	x	-22.97	-22.93	-22.95	-22.95	-22.95	-22.95
	y	-5.82	-6.28	-6.48	-6.52	-6.52	-6.52
	z	35.89	42.34	45.80	46.47	46.54	46.54
	res	39.99	46.54	49.86	50.56	50.65	50.65
Relative	x	49.67	50.56	50.95	50.94	50.95	50.95
	y	25.43	26.09	26.56	26.56	26.56	26.56
	z	54.32	54.91	55.77	55.90	55.92	55.92
	res	70.22	71.45	72.34	72.44	72.43	72.43
Displacement (in)							
Absolute	x	-1.57	-1.58	-1.58	-1.58	-1.58	-1.58
	y	-0.60	-0.60	-0.60	-0.60	-0.60	-0.60
	z	2.09	2.09	2.09	2.09	2.09	2.09
	res	2.12	2.12	2.12	2.12	2.12	2.12
Relative	x	7.94	7.94	7.94	7.94	7.94	7.94
	y	6.23	6.23	6.23	6.23	6.23	6.23
	z	8.74	8.74	8.74	8.74	8.74	8.74
	res	13.35	13.35	13.35	13.35	13.35	13.35

Roosevelt (CVN71)

Test number : 4

Gauge location : Head (angular)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (rad/s/s)							
Absolute	x	-125.33	256.47	358.51	393.35	403.83	401.58
	y	-427.61	-558.76	-639.92	-729.46	-777.47	-777.07
	z	43.89	84.59	120.35	132.68	136.35	135.91
	res	433.06	567.32	641.02	739.15	808.70	809.06
Velocity (rad/s)							
Absolute	x	-2.19	-2.34	-2.40	-2.41	-2.42	-2.42
	y	-7.86	-8.54	-8.72	-8.74	-8.74	-8.74
	z	-1.62	-1.66	-1.66	-1.66	-1.66	-1.66
	res	8.06	8.72	8.90	8.93	8.94	8.94
Displacement (rad)							
Absolute	x	-0.12	-0.12	-0.12	-0.12	-0.12	-0.12
	y	-0.59	-0.59	-0.59	-0.59	-0.59	-0.59
	z	-0.23	-0.23	-0.23	-0.23	-0.23	-0.23
	res	0.64	0.64	0.64	0.64	0.64	0.64

Roosevelt (CVN71)

Test number : 4

Gauge location : T-1 (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-0.87	-1.98	-2.83	-3.07	-3.17	-3.17
	y	-0.44	0.81	-1.12	-1.30	-1.44	-1.45
	z	7.32	13.47	17.37	17.79	17.71	17.70
	res	7.37	13.61	17.60	18.06	17.99	17.98
Relative	x	3.44	5.34	7.35	8.28	8.86	8.86
	y	3.96	6.29	10.76	13.53	14.38	14.38
	z	6.71	15.75	20.65	21.74	22.95	22.93
	res	7.60	16.36	21.12	22.17	23.66	23.65
Velocity (in/s)							
Absolute	x	15.52	15.34	15.29	15.26	15.25	15.24
	y	-2.59	-2.61	-2.64	-2.64	-2.65	-2.65
	z	43.34	51.49	55.59	56.15	56.18	56.18
	res	43.56	51.91	56.09	56.65	56.68	56.68
Relative	x	27.29	29.54	30.74	30.85	30.88	30.88
	y	23.72	24.33	24.61	24.94	25.03	25.03
	z	53.07	53.90	54.84	54.96	54.96	54.96
	res	59.97	61.12	62.06	62.16	62.16	62.16
Displacement (in)							
Absolute	x	1.58	1.58	1.58	1.58	1.58	1.58
	y	-0.26	-0.26	-0.26	-0.26	-0.26	-0.26
	z	2.35	2.35	2.35	2.34	2.35	2.35
	res	2.35	2.35	2.35	2.35	2.35	2.35
Relative	x	6.15	6.15	6.15	6.15	6.15	6.15
	y	5.89	5.89	5.89	5.89	5.89	5.89
	z	7.77	7.77	7.77	7.77	7.77	7.77
	res	11.53	11.53	11.53	11.53	11.53	11.53

Roosevelt (CVN71)

Test number : 4

Gauge location : Pelvis (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	-2.01	-3.89	-4.72	-4.59	5.03	5.03
	z	7.32	14.10	21.85	25.76	27.36	27.36
Relative	x	3.48	4.86	5.35	6.05	6.78	6.79
	z	5.63	10.80	16.97	20.27	21.93	21.95
Velocity (in/s)							
Absolute	x	13.00	13.10	13.11	13.11	13.11	13.11
	z	43.27	48.66	51.33	51.23	51.08	51.08
Relative	x	29.10	32.23	33.45	33.72	33.77	33.77
	z	54.97	55.67	56.60	56.72	56.73	56.73
Displacement (in)							
Absolute	x	2.00	2.00	2.00	2.00	2.00	2.00
	z	2.45	2.45	2.45	2.45	2.45	2.45
Relative	x	5.73	5.73	5.73	5.73	5.73	5.73
	z	7.98	7.98	7.98	7.98	7.98	7.98

Roosevelt (CVN71)

Test number : 4

Gauge location : Chair/deck (linear)

Frequency (Hz)		15	30	60	100	300	None
Acceleration (g)							
Absolute	x	2.58	3.54	5.07	6.11	6.71	6.72
	y	4.10	6.35	-10.78	-13.56	-14.41	-14.40
	z	7.01	11.44	15.11	15.64	15.64	15.67
	res	8.11	13.11	16.60	16.89	16.75	16.82
Velocity (in/s)							
Absolute	x	27.55	27.88	28.27	28.32	28.36	28.36
	y	21.95	22.50	23.68	24.02	24.12	24.12
	z	44.21	50.06	51.99	52.52	52.87	52.87
	res	49.94	55.11	57.90	58.55	58.86	58.86
Displacement (in)							
Absolute	x	7.73	7.73	7.73	7.73	7.73	7.73
	y	5.63	5.63	5.63	5.63	5.63	5.63
	z	8.78	8.78	8.78	8.78	8.78	8.78
	res	12.98	12.98	12.98	12.98	12.98	12.98